

such terrible wounds with the tail. I have seen one literally split the end of a person's finger, and another wound the hand through a thick leather glove. I believe the Squills to be, as Cuvier supposed, carnivorous. I have carefully examined the stomachs of some, and have always found them to contain the remains of small crustaceans, but no vegetable matter. Their flesh is excellent; but the great strength of their integument renders it difficult to detach it. The most extraordinary circumstance in the distribution of the branches of the heart is that it has no apparent connexion with the antennæ or the eyes.

"This beautiful creature would be a great ornament to an aquarium; but, unfortunately, I have never been able to keep an adult specimen alive more than a few hours after it was caught, though using every precaution—placing it in a vessel as soon as it was taken from the sea, and renewing the water at short intervals. When young I have preserved them for days, and might, perhaps, have preserved them indefinitely had I persevered in the attempt. I have known them exist in full vitality for twelve or fifteen hours without water."

Mr. George Dawson Rowley, F.Z.S., exhibited, and read the following remarks upon, a specimen of a rare Asiatic Thrush (*Turdus atrogularis*, Temminck) recently killed in this country, this being its first recorded appearance in the British islands:—

"The specimen of *Turdus atrogularis* was shot near Lewes, Sussex, on December 23rd, 1868. It is a young male, as shown by its plumage; dissection also confirmed the fact. I saw the bird in the flesh, and took particular care to ascertain its history, because it belongs to the fauna of Central Asia, and is only an accidental visitor to Europe. To find such a species on the south coast of England appears to me a matter of considerable interest. It is now in the collection of T. J. Monk, Esq., of Mountfield House, near Lewes, who purchased it for a trifle of a working-man."

The following papers were read:—

1. On the Value of the Characters of the Base of the Cranium in the Classification of the Order Carnivora, and on the Systematic Position of *Bassaris* and other disputed Forms. By WILLIAM HENRY FLOWER, F.R.S., F.Z.S., &c., Conservator of the Museum of the Royal College of Surgeons.

The Order Carnivora has always been an attractive one to zoologists; and consequently nearly all the important structural modifications which occur among its members are so well known that it is surprising that there is not yet a more universal accord of opinion upon their arrangement and mutual affinities.

Too exclusive attention has been paid to the characters of the teeth in defining the family divisions of the order. The difficulty in the taxonomic use of these organs arises from the fact that the teeth of all the members of such a limited and well-defined group as the terrestrial or fissipedal Carnivora are formed on the same general type, but with infinite modifications of this type. And as these modifications are mainly adaptive and not essentially indicative of affinity, they reappear in various degrees and combinations in many of the great natural divisions of the order. Thus, as will be shown further on, teeth alone afford us no satisfactory means of diagnosis between the very distinct groups of the *Procyonidæ* and the *Viverridæ*. The teeth of *Proteles*, though demonstrating undeniably its right to a place in the order, are so rudimentary or generalized that they afford no help whatever to determine its special position. Again the teeth of *Gulo* are so similar to those of *Hyæna*, that if this character alone were used, these two otherwise widely differentiated forms would be placed in the closest proximity. *Enhydris*, among the Mustelidæ, and *Cynogale*, among the Viverridæ, might also be cited as examples of strangely modified dentition, with comparatively little corresponding change in other parts.

Rather more than twenty years ago the late Mr. H. N. Turner*, in a paper read before this Society, pointed out the importance of certain structural peculiarities of the base of the cranium in the classification of the Mammalia, and especially demonstrated the constancy of these characters in the various members of the natural divisions of the order Carnivora†. Very few subsequent zoological writers, however, have followed out the indications suggested in that communication; and Mr. Turner's views as to the position of certain disputed forms, and the general relationship of the groups one to another, have not by any means met with universal acceptance.

It seems desirable therefore to test whether the characters chiefly relied upon by Mr. Turner really have the value which he attributed to them. In endeavouring to do this I shall find it necessary to give a more detailed description than the limits of his paper allowed, to supply a larger number of illustrative examples, and, while fully recognizing the great merit of his observations, may find myself occasionally obliged to differ from the conclusions which he deduced from them.

It may be objected at the outset that such an investigation cannot be worth the pains bestowed upon it, as any classification founded solely or even mainly on one limited portion of the organization must necessarily be an artificial one. But if it can be proved that the modifications of any one part are always correlated with important variations in several other and quite unconnected portions of the organization, it is obvious that its study will become of great practical

* This original and accurate observer fell a victim to his zeal for his favourite science, having died in 1851 from the effects of a dissection-wound.

† "Observations relating to some of the Foramina in the Base of the Skull in Mammalia, and on the Classification of the Order Carnivora," by H. N. Turner, jun. (P. Z. S. 1848, p. 63).

utility to the zoologist; and this will be more especially the case when the part in question is one so imperishable, so easy of examination, and affording indications so clear and capable of ready definition and description, as the base of the skull.

In order not to extend this communication to too great length, or over too great a variety of subjects, I propose to limit my observations on the present occasion mainly to the terrestrial or fissipedal Carnivora, and only to those genera now existing. My reason for this last restriction is, that it is only in these that we have the opportunity of thoroughly working out all the important points of structural modification throughout the system, and thus definitely assigning their position; and from these only can we hope to establish any correlation between the structure of the hard and imperishable parts and the viscera. When such a correlation has been established, then the examination of the fragmentary remains of the extinct forms can be made with much greater advantage, and the work of tracing the stages by which the present condition of the order has come into being can be approached with more probability of a satisfactory result.

The region to which attention will now be especially directed is the posterior part of the base of the cranium, the most conspicuous feature in which, in all Carnivora, is the auditory bulla; and it is mainly the characters of this bulla, and the structures immediately surrounding it, which will be described in the principal genera of the order.

Following Mr. Turner's example, I will first take one of the extreme forms of existing terrestrial Carnivores, the Bear.

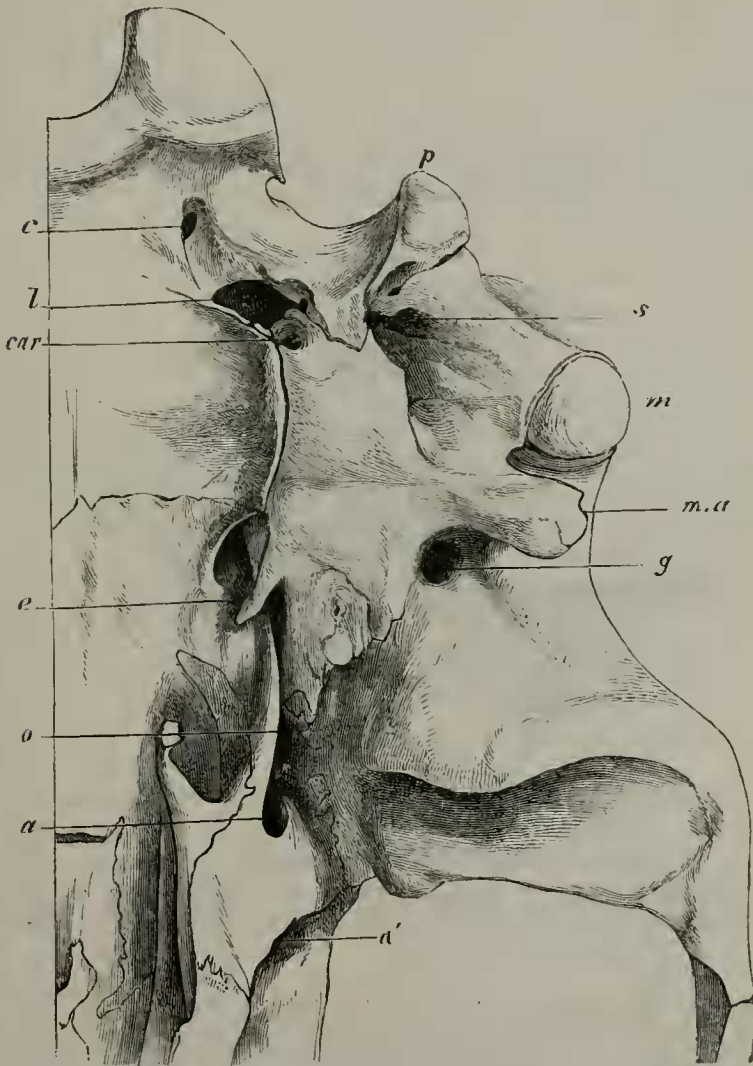
Figures 1 and 2 (pp. 7 & 8) are taken from the skull of a not quite adult *Ursus ferox* in the Museum of the Royal College of Surgeons (No. 4016).

The auditory bulla is comparatively little inflated. It consists of a single bone, readily detached from the cranium in skulls of young animals. Its form is more or less triangular, being broad and nearly straight at the inner edge, and prolonged outwards into the much produced floor of the external auditory meatus (*m.a*). Its greatest prominence is along the inner border; from this it gradually slopes away towards the meatus. Near the hinder part of the inner edge is a considerable circular foramen (*car*), which pierces the bone obliquely, leading to a canal which runs forwards in an arched direction, in its inner wall. This is the carotid canal. In old Bears the entrance is partly concealed by the prominent lip of the basioccipital, which abuts against the inner edge of the bulla; and by the growth of this and of the paroccipital process it becomes almost included in the deep fossa leading to the foramen lacerum posticum (*l*). Anteriorly the carotid canal of the bulla ends close to the inner side of the groove for the eustachian tube; and the artery quitting it takes a sudden turn upwards and backwards and enters the cranium through the foramen lacerum medium.

When a section is made through the auditory bulla (see fig. 2, p. 8) it is seen to be a simple thin-walled bony capsule, imperfect above, where it fits on to the petrosal and squamosal bones, and prolonged

externally into the much thickened spout-like floor of the meatus externus.* At the inner extremity of this floor is a freely projecting oval lip (*t*), which gives attachment to the membrana tympani, and

Fig. 1.



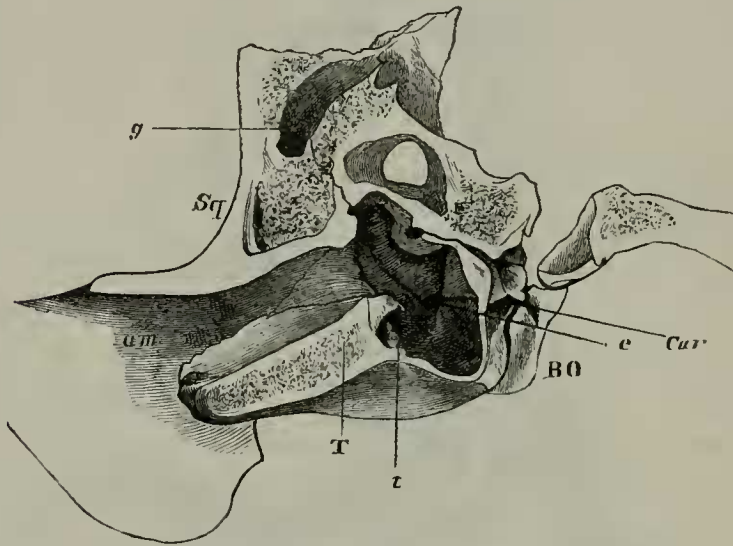
Part of the base of the skull of the Grizzly Bear (*Ursus ferox*).

- c.* The condyloid foramen. *l.* The foramen lacerum posticum. *car.* The carotid canal. *e.* The eustachian canal. *o.* The foramen ovale. *a.* the posterior, and *a'* the anterior, opening of the alisphenoid canal. *p.* The paroccipital process. *m.* The mastoid process. *s.* The stylo-mastoid foramen. *m.a.* The external auditory meatus. *g.* The glenoid foramen*.

* This and all the figures, except figs. 9, 10, and 14, are taken from specimens in the Museum of the Royal College of Surgeons. All are of the natural size, except fig. 4, which is enlarged.

which is the original and first ossified ring-like portion of the tympanic bone. In the front of the floor of the bulla is the groove for the eustachian canal (*e*); between this and the anterior part of the tympanic ring, a low and thin ridge of bone with a concave free margin rises from the floor of the cavity. This is the only indication of any septum or division of the cavity of the bulla. Whether the whole of this bone is developed from the original tympanic, or whether the bullate inner portion is (as will be shown to be the case in some other Carnivora) ossified from a distinct cartilage of its own, I am not at present able to determine. In the youngest Bears' skulls that I have examined, the ossification of the whole bulla is continuous with that of the tympanic ring and floor of the meatus.

Fig. 2.

Section through the auditory bulla of *Ursus ferox*.

Sq. Squamosal bone. *T.* Tympanic bone. *BO.* Basioccipital. *g.* Glenoid canal. *a.m.* External auditory meatus. *t.* Tympanic ring. *e.* Eustachian canal. *car.* Carotid canal.

Behind the bulla (fig. 1, p. 7) the prominent and tuberos paroccipital process (*p*) projects downwards, outwards and backwards, standing quite off from the bulla, and only connected with it by a low laterally compressed ridge. Between the paroccipital process and the occipital condyle is a smooth concave surface, the front of which is excavated into a deep notch, the posterior boundary of the foramen lacerum posticum (*l*), between which and the condyle is the distinct subcircular foramen condyloideum (*c*), which transmits the hypoglossal nerve.

At the outer side of the bulla, just behind the meatus auditorius externus, the mastoid process (*m*) is distinct and prominent, and widely separated from the paroccipital. At the bottom of a deep

hollow between these processes and the bulla is placed the stylo-mastoid foramen (*s*), through which the facial nerve makes its exit from the cranium*.

Immediately in front of the commencement of the meatal prolongation of the tympanic, at the base of the postglenoid process of the squamosal is a conspicuous opening called foramen glenoideum (*g*), which leads to a venous canal which runs upwards and backwards into the lateral sinus.

Still more forward, immediately to the inner side of the glenoid fossa, is the foramen ovale of the alisphenoid (*o*), transmitting the third branch of the fifth nerve, and bounded and partly covered on the inner side by a strong ridge of bone. Close in front of this is the hinder aperture of the large canal (*a*), bridged over by a lamina of bone from the alisphenoid, to which Mr. Turner has particularly directed attention under the name of "alisphenoid canal." Through this the ectocarotid artery runs for a part of its course. It opens in front by a common aperture with the foramen rotundum (*a'*).

With this the list of the parts to which it is necessary to refer at present concludes. The description just given will apply, with trifling modifications, to all known species of the genus *Ursus*, including the subgenera *Thalassarctos*, *Helarctos*, and *Prochilus*.

Passing to the animals usually considered most nearly allied to the Bears, *Procyon* (fig. 3, p. 10) has the auditory bulla more dilated and prominent, it is true, than in *Ursus*, but with the same general form, *i. e.* rising abruptly on the inner side, most prominent near the middle of the inner edge, sloping off behind and before this point, and flattened at the outer side, where it is continued into the prolonged under lip of the auditory meatus. Moreover it is simple within, undivided by any distinct septum; on looking into the meatus the opposite wall can be distinctly seen, or a probe can be passed to it without meeting with any impediment.

The aperture of the carotid canal (*car*) is large, and rather more advanced and more distinct from the foramen lacerum posticum (*l*) than in the Bears. The paroccipital process (*p*) stands away from the bulla; the mastoid (*m*) is very distinct. The condyloid foramen (*c*) is freely exposed on the surface, and quite distinct from the foramen lacerum posticum. The glenoid foramen (*g*) is large and conspicuous, though somewhat overlapped by the margin of the tympanic bone. The alisphenoid canal is completely wanting; this is the most important distinction from the true Bears.

In *Nasua* the bulla is still more rounded and prominent; indeed its resemblance to that of the Bear is chiefly in its simplicity, and in the prolongation of the auditory meatus. The carotid foramen is advanced to the middle of the bulla. The paroccipital and mastoid processes, and condyloid foramina, are as in *Procyon*. The glenoid foramen is more conspicuous. There is no alisphenoid canal.

Cercoleptes presents a great difference from *Nasua* and *Procyon*

* The modifications of this foramen in situation will not be noticed hereafter, as they depend simply on the amount of inflation of the external portion of the bulla.

in the form of the auditory bulla—it being more like that of *Ursus*, except that it is rather longer from before backwards, and slightly more bullate. The carotid foramen, however, differs widely in its position from that of the Bear, being placed very conspicuously rather in front of the middle of the inner edge of the bulla. The paroccipital and mastoid processes are not much developed, partaking of the general flattening that the base of the cranium seems to have undergone, but they occupy the same relative position as in the

Fig. 3.



Fig. 3a.

Fig. 3. Under surface of the skull of the Raccoon (*Procyon lotor*).3a. Under surface of the skull of *Bassariscus astuta*.

(The letters as in fig. 1.)

foregoing genera. The first-named is much compressed and turned backwards. The condyloid foramen is conspicuous; but the glenoid foramen, though present, is reduced to a mere slit by the overlapping of the tympanic bone and shortness of the postglenoid process. The alisphenoid canal is absent.

In the singular genus *Ailurus* the auditory bulla is very small and simple, prominent and rounded on the inner side, with a very prolonged bony floor to the external auditory meatus. The carotid canal is large and distinct, rather behind the middle of the inner edge of the bulla. Paroccipital process long and trigonal, standing backwards and outwards, quite unconnected with the bulla, curved inwards at the extremity in old animals. The condyloid foramen is distinct in a flat exposed surface between the paroccipital and condyle. There is a well-developed rounded mastoid process, quite distinct from the paroccipital. The glenoid foramen is large, situated between the inner end of the tympanic meatus and the most prominent part of the large postglenoid process. There is a distinct alisphenoid canal.

To pass to the *Mustelidæ*:—*Lutra* is extremely Ursine in the base of its skull, although all the bones (including the auditory bulla) are remarkably thinned-out and flattened. The meatus is much prolonged. The carotid foramen is placed rather nearer the anterior than the posterior part of the inner edge of the bulla. The glenoid foramen is very distinct. The cavity of the auditory bulla (as is the case with many of the *Mustelidæ*) is divided into several freely intercommunicating cells by thin incomplete bony septa placed transversely across the floor of the bulla, and connected at their outer end with the tympanic ring. The paroccipital process is greatly compressed from before backwards. The mastoids are prominent laterally. The foramen lacerum posticum very large. There is no alisphenoid canal.

Enhydris differs from *Lutra* chiefly in the large size and more posterior position of the carotid foramen, and the very small size of the glenoid foramen.

Meles presents, in the most characteristic manner, the form of auditory bulla assigned by Mr. Turner to this group, "rising suddenly on its inner side, and flattened off towards the meatus." Internally it has two transverse imperfect septa rising from the floor. The meatus is considerably prolonged. The paroccipital and mastoid processes are very well developed and far apart, the former rather compressed and pointed, the latter tuberos. The carotid foramen is placed rather behind the middle of the bulla. The condyloid foramen is small, its hinder border partially overlapped by a slight ridge of bone passing from the paroccipital process to the condyle; but it is quite superficial and distinct from the foramen lacerum posticum. The glenoid foramen is distinct, though not very large. There is no alisphenoid canal.

Taxidea differs from *Meles* in the remarkably inflated condition of the auditory bulla. Essentially, however, its characters are much the same; the bulla is not so dilated at its hinder part as to come into contact with the paroccipital process, though in front it reaches to such an extent as to overlap and obscure the glenoid foramen. It has several partial transverse septa.

In *Mephitis*, on the other hand, this region of the skull is nearly as much expanded and flattened as in the Otters. The bulla forms a very small prominence. The paroccipital process is widely separated

from it; and the mastoid projects directly outwards. The bony meatus is of considerable length. The carotid foramen is large, placed at the middle of the inner border of the bulla. The condyloid foramen is large and quite exposed. The glenoid foramen is represented by a small hole just above the superior anterior angle of the meatus externus.

In *Helictis* the auditory bulla is elongated from before backwards, the hinder part, near the paroccipital process, being more inflated than usual; consequently this process, which is but feebly developed, does not stand so far off from the bulla as is usual in the group. The meatus is moderately produced. The carotid foramen is conspicuous at the middle of the inner border of the bulla. The condyloid foramen is partially concealed and thrown forwards by the ridge extending inwards from the paroccipital process. The glenoid foramen is placed above the auditory meatus. On the whole these parts exhibit a more generalized and less characteristic form than in most other members of the group.

Arctonyx has the base of the skull very flat and expanded laterally. The bulla small, but elevated and rounded near the inner edge. Floor of meatus very long, wide, and flat. Canal of meatus large, directed somewhat downwards and forwards as well as outwards. Carotid foramen large, placed near the hinder part of the bulla. Paroccipital process well developed, quite distinct from the bulla, flattened from before backwards, curving forwards at the extremity. Mastoid very large, flattened and rough behind, rounded and smooth in front, projecting outwards, downwards, and forwards. Glenoid foramen distinct. Postglenoid process rather small. No alisphenoid canal. Great peculiarities in the base of the skull are the remarkable extension of the bony palate backwards, reaching as far as the glenoid fossæ, and the lateral bullate expansion of the palate-bones behind the last molar tooth.

Mydaus presents the same general characters as *Arctonyx*; but, as might be expected in a smaller animal, the bulla is rather more inflated, the paroccipital and mastoid processes less developed, and the meatus less elongated. The palate also does not extend so far backwards, and wants the peculiar lateral dilatation.

In *Gulo* the auditory bulla is like that of the Bear, but rather more dilated. It contains several partial transverse septa. The meatus is much prolonged. The carotid canal is rather behind the middle, and almost completely concealed by the thickened edge of the basioccipital. The condyloid foramen has a strong ridge behind it, and approaches very near to the foramen lacerum. The paroccipital process is compressed and triangular. The mastoid is very strong, and directed laterally, though turned downwards at the extremity. The glenoid foramen is conspicuous. There is no alisphenoid canal.

All the remaining genera have the auditory bulla rather large, and the floor of the meatus, though forming a distinct prolongation from the bulla, comparatively short.

In *Mellivora* the bulla is very prominent, oval, thick-walled, and rough on the surface. The paroccipital process is stout and trian-

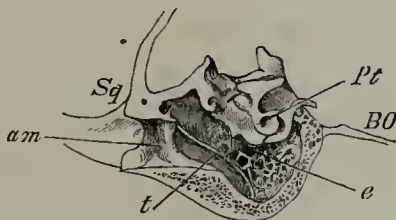
gular, the mastoid process strong and rounded. The carotid foramen conspicuous, near the middle of the inner border of the bulla. The condyloid foramen not bounded posteriorly by a ridge. The glenoid foramen large, close to the anterior edge of the meatus externus.

In *Galera* the bulla is less prominent, the carotid foramen partly concealed by the basioccipital. The glenoid foramen large, and rather more internally placed than in the last.

In *Martes* the bulla is elongated from before backwards. The paroccipital and mastoid processes are small. The carotid foramen is partly concealed by the basioccipital. The condyloid foramen partially overhung posteriorly by the ridge from the paroccipital. The glenoid foramen large, situated at the upper anterior angle of the auditory meatus.

In *Mustela* the dilatation and elongation of the bulla is carried to a great extent. The meatus is directed much forwards, and appears externally to be very short; but this is occasioned (as shown in the transverse section, fig. 4) by its inferior lip being covered up by a thick layer of cancellous tissue, of which the whole parietes of the bulla are to a great extent composed, and which adds much to its external bulk. But for this peculiarity, the general form of the cavity is not unlike that of *Ursus*. In addition to this cancellous structure in the wall, a considerable portion of the interior, especially of the inner and lower parts, is pervaded by numerous fine osseous septa and trabeculae. The paroccipital and mastoid processes are very feebly developed, especially in the smallest members of the group, where they are flattened and lost on the expanded posterior end of the bulla. The carotid foramen is placed conspicuously at, or rather in front of, the middle of the long straight inner wall of the bulla. The condyloid foramen is quite exposed, and distinct from the foramen lacerum. The glenoid foramen is tolerably large, and situated just in front of the external auditory meatus. As in the preceding genera, there is no alisphenoid canal.

Fig. 4.



Section through the auditory bulla of the Polecat (*Mustela putorius*). Twice the size of nature.

(The letters as in fig. 2.) *Pt.* The petrosal.

In *Rhabdogale* the form of the auditory bulla externally much resembles that of *Mustela*, though rather less inflated; but a section shows that its walls want the peculiar cancellous structure noticed in

that genus. There are only a few partial septal bands across the floor, as in the Badgers. The anterior inferior extremity of the bulla is pointed, and commonly united to the prolonged hamular process of the pterygoid.

The whole of the genera above described are united by Mr. Turner into one family, *Ursidæ*; and that they constitute a natural group, I think no one should doubt, even on grounds independent of their cranial characters. They all agree in having the intestinal canal without a cæcum, all other known Carnivora possessing this appendage. Moreover they all agree together, and differ from all other Carnivora, in the structure of the generative organs of the male, parts of considerable value in determining affinities. They all have a large penis, with a very considerable bone, which is usually more or less curved, somewhat compressed, not grooved, dilated posteriorly, and often bifurcated, or rather bilobed, in front. They are all destitute of Cowper's glands. All have the prostate rudimentary, or consisting only of a thickening of the wall of the urethra and forming no distinct prominence.

Among all the diversity that has been shown to exist in the characters of the base of the cranium, especially in the form of the auditory bulla, the following points of general agreement are to be found:—

1. The cavity of the bulla is simple (as compared with another form to be described presently). That is, although there are frequently trabeculae or partial septa passing mostly transversely across the lower part, and generally connected with the tympanic ring, there is no distinct and definite septum dividing it into a separate outer and inner character. In all cases, on looking into the external auditory meatus (in the dried skull when the membrana tympani is removed) the opposite wall of the bulla can be seen; or if a probe is passed into the meatus, no obstacle will prevent its touching the inner wall. Whatever the diversity of development of the bulla, it always has its greatest prominence near the middle of the inner border, and slopes away from that point, not only externally, but also forwards and backwards.

2. The inferior lip of the external auditory meatus is always considerably prolonged.

3. The paroccipital process is more or less triangular, and directed backwards, outwards, and downwards, standing quite aloof from the bulla. This relation depends chiefly on the want of development of the posterior portion of the bulla; and is absent, or obscure, in *Mustela* alone.

4. The mastoid process is widely separated from the paroccipital, and generally very prominent.

5. The carotid foramen is always large, and placed usually near the middle, but sometimes more posteriorly, on the inner margin of the bulla. It is generally very conspicuous, but sometimes partially concealed by the projecting lip of the basioccipital.

6. The condyloid foramen is distinct and exposed; and although sometimes partially overlapped posteriorly by a ridge of bone passing

from the paroccipital to the condyle, it is never sunk into a common opening with the foramen lacerum posticum.

7. The glenoid foramen is always present, and generally very conspicuous. In *Enhydris* it is least so.

8. The alisphenoid canal is present in the true Bears and *Ailurus*, absent in all the others. Hence it cannot be used to characterize the entire group, though useful in aiding its subdivision.

The group thus defined is, I think, too extensive, and presents too great variation among its members, in dentition and external characters, to constitute a Family, as proposed by Mr. Turner. I would rather regard it as a primary section of the fissipedal Carnivora, to which the name of ARCTOIDEA might be given.

I perfectly agree with Mr. Turner that it is further divisible into four chief sections, or families, as I should call them—the *Ursidæ*, *Ailuridæ*, *Procyonidæ*, and the *Mustelidæ*. The further consideration of these divisions must be reserved for the present, my purpose now being to establish the group *Arctoidea* upon a perfectly secure basis.

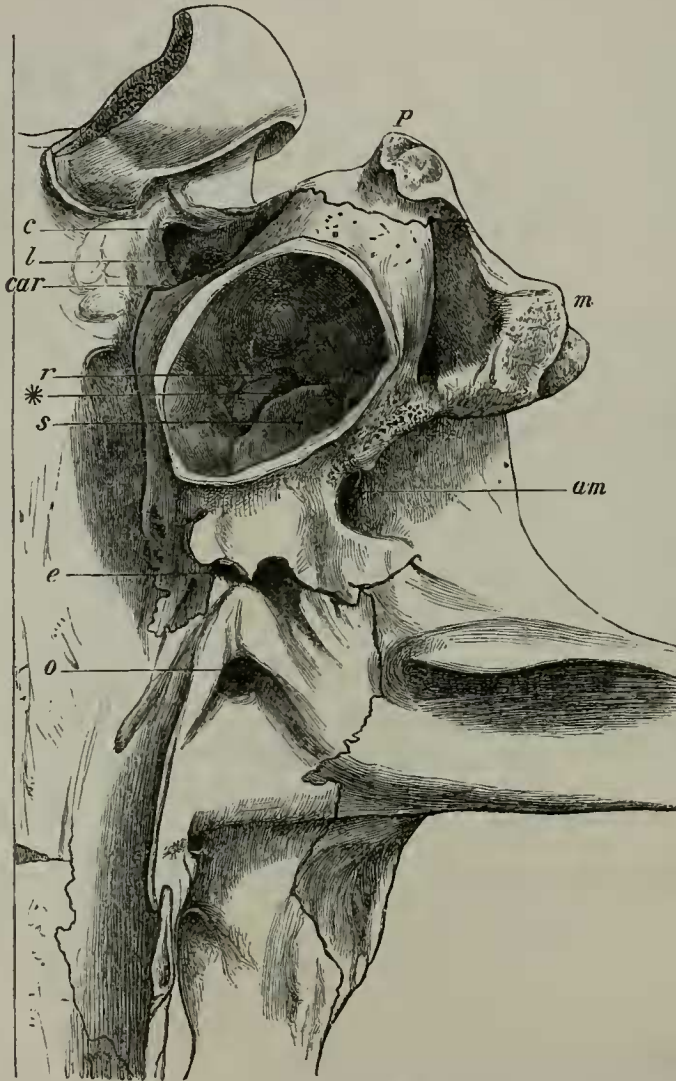
I will now pass to a genus as far removed from the Bear in its general structure as it will be seen to be in the construction of the base of its skull, *Felis*. Figs. 5 and 6 (pp. 16 & 17) are taken from the Tiger (*F. tigris*).

The auditory bulla is very prominent, rounded and smooth on the surface, rather longer from before backwards than transversely, its greatest prominence being rather to the inner side of the centre. The lower lip of the external auditory meatus (*a.m*) is extremely short; the meatus, in fact, looks like a large hole opening directly into the side of the bulla. On looking into this hole, at a very short distance (in fact, just beyond the tympanic ring) a wall of bone is seen, quite impeding the view or the passage of any instrument into the greater part of the bulla. On making a section (fig. 6), it will be seen that this wall is a septum (*s*) which rises from the floor of the bulla, along its outer side, and divides it almost completely into two distinct chambers; one (*o.c*), outer and anterior, is the true tympanic chamber, and contains the tympanic ring, membrane, and ossicula, and has at its anterior extremity the opening of the Eustachian tube (*e*); while the other (*i.c*), internal and posterior, is a simple but much larger cavity, having no aperture except a long but very narrow fissure (*) left between the hinder part of the top of the septum and the promontory of the petrosal, which fissure expands posteriorly, or rather at its outer end, into a triangular space, placed just over the fenestra rotunda or cochlearea (*r*), so that the opening of this fenestra is partly in the outer and partly in the inner chamber of the bulla. This chamber is formed by a simple capsule of very thin but dense bone, deficient only at a small oval space in the roof, where the petrosal projects into and fills up the gap, except such portion of it as is left to form the aperture of communication with the outer chamber.

Not only are these two chambers thus distinct, but they are originally developed in a totally different manner. At birth the only ossification in the whole structure is the incomplete ring of bone sup-

porting the membrana tympani, and developed originally in membrane. Ossification extends from this, so as to complete the outer chamber and the very limited lip of the meatus auditorius externus. The inner chamber is formed from a distinct piece of hyaline cartilage, which at birth is a narrow slip, pointed at each end, lying between the tympanic ring and the basioccipital, applied closely to

Fig. 5.

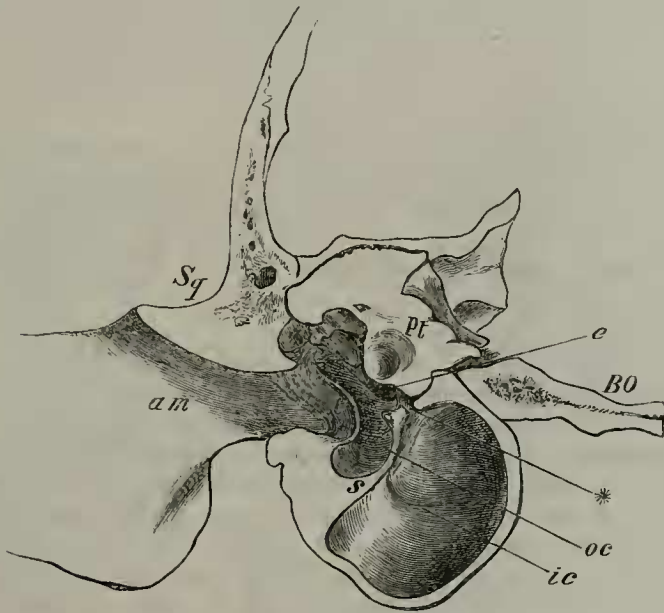


Part of the base of the skull of the Tiger (*Felis tigris*). A portion of the auditory bulla has been removed to show its interior. The cavity of the inner or posterior chamber is exposed.

r. The fenestra rotunda in the petrosal. *s.* The septum between the chambers.
* The aperture of communication. The other letters as in the preceding figures.

the surface of the already ossified petrosal, and forming no distinct prominence on the under surface of the skull*. Soon after birth this increases in size, and gradually assumes the bullate form of the wall of the inner chamber. In young animals, even some time after the ossification of the bulla is complete, the distinction between the two parts is clearly seen externally; not only are they marked off by a groove, but the tympanic portion has a more opaque appearance than the other.

Fig. 6.



Section of the auditory bulla of the Tiger.

oc. The outer chamber. *ic.* The inner chamber. *s.* The septum. * The aperture of communication between the chambers. The other letters as in the preceding figures.

The septum is formed by an inversion of the walls of both, applied together and ultimately perfectly fused in *Felis*, although, as will be seen, permanently distinct in some other allied forms†.

No indication of a carotid foramen can be seen anywhere on the

* The cartilage from which the auditory bulla of the *Felidae* is developed evidently corresponds with that lamella of the "opisthotic" of Man which "gradually wraps itself round the carotid, and so converts the primitive groove for the vessel into a complete tube, at the same time furnishing the inner part of its floor to the tympanum" (Huxley, *Elements Comp. Anatomy* (1864), p. 155).

† These parts are all described in great detail in Straus-Durckheim's '*Anatomie du Chat*' (1845), vol. i. pp. 409 *et seq.* He calls the outer chamber the "caisse du tympan," the inner one the "cavité mastoïdienne," or "seconde chambre de la timbale," regarding it as the "analogue" of the mastoid cells of man. This part, he says, "ne commence que par un seul point d'ossification qui ne paraît même que quinze jours après la naissance; et à six semaines il est entièrement formé, et articulé avec tous les os voisins." The septum, or "cloison," is "commune aux deux os, formée par deux lames adossées et soudées entre elles."

inner side of the bulla, where it was so conspicuous in most of the Arctoidea, but it is represented by a minute groove (*car*) deep in the recess of the foramen lacerum posticum. In the smaller members of the genus this groove is more superficial, but always very minute, and apparently never converted into an actual foramen except by the contiguous wall of the basioccipital.

The paroccipital process (*p*) is flattened out over the back of the bulla, being applied closely to the whole of its prominent rounded hinder end, and projecting, as a rough tubercle, slightly beyond it. From the inner side of this process a strong sharp ridge runs towards the occipital condyle. This forms the posterior boundary of a deep fossa, at the bottom of which is the foramen lacerum posticum (*l*), and in the hinder part of which, under cover of the aforesaid ridge, the foramen condyloideum (*c*) opens.

The mastoid process (*m*) is a moderately conspicuous rough prominence, not very widely separated from the paroccipital.

There is no distinct glenoid fossa, nor is there an alisphenoid canal.

This description applies equally well to all the true cats (genus *Felis*), including the slightly aberrant Cheetah, but not to any other members of the Order.

I pass next to the *Viverridæ*.

In the African Civet (*Viverra civetta*) (fig. 7, p. 19) the auditory bulla is very prominent, smooth and oval, broader behind than before. The meatus has scarcely any inferior lip, its orifice (*am*) being close to the tympanic ring. The part of the bulla immediately surrounding the meatus is separated by a distinct groove from the much larger, more inflated, and more transparent inner, or, rather, *posterior* part, as it is in this animal. There is a septum within, disposed exactly as in *Felis*, but very short, owing to the small space it has to fill up, occasioned by the slight dilatation of the outer chamber. It is applied closely to the petrosal above, leaving a mere linear fissure, probably closed in the living animal, expanded at one end into a small triangular space, situated just over the fenestra rotunda.

Instead of a carotid canal, there is a groove (*car*) on the inner side of the bulla, near its anterior end.

The paroccipital (*p*) is triangular, spread very evenly over the hinder part of the bulla, applied to it "like the capsule of the acorn to the seed"*, and projecting slightly beyond it, as a rough pointed process. The ridge running from its inner side bounds the common fossa into which the condyloid foramen (*c*) and the foramen lacerum posticum (*l*) open.

The mastoid process can be scarcely said to exist. An extremely minute aperture near the hinder end of the postglenoid process may represent the glenoid foramen. There is a distinct alisphenoid canal (*a*).

In the Rasse (*Viverra malaccensis*) the bulla is large, as wide in front as behind, much elongated, narrow, and compressed laterally, corresponding, in fact, with the proportions of the entire cranium. Otherwise its structure is essentially the same as that of the Civet.

* Owen, Cat. Osteological Series in Mus. Roy. Coll. Surg. vol. ii. p. 680.

The anterior chamber is rather more developed, and less distinctly marked off externally from the posterior. The orifice of the meatus is very large, and opens directly into the tympanic cavity. The carotid enters by a distinct groove near the middle of the inner wall of the bulla, partially concealed and converted into a canal by the lip of the basioccipital.

The paroccipital process is smoothly expanded over the posterior part of the bulla, but does not project beyond it. The mastoid process is not very distinct. The condyloid foramen is much overhung by the ridge from the paroccipital. The glenoid foramen is very minute.

Fig. 7.

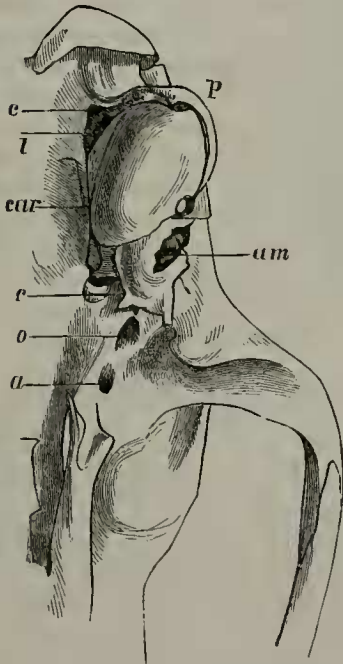
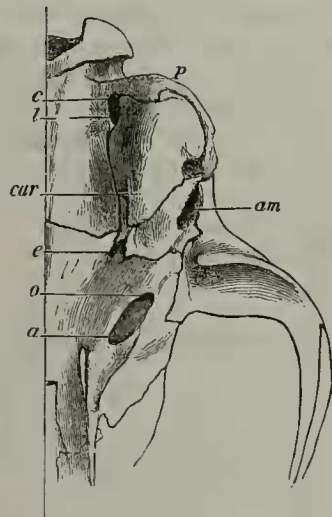


Fig. 8.

Fig. 7. Civet (*Viverra civetta*).8. Paradoxure (*Paradoxurus bondar*).

(The letters as in the preceding figures.)

Mr. Turner remarked that in this species the alisphenoid canal is not developed; but I find, on examining a series of seven skulls in the Museum of the Royal College of Surgeons, that in one this canal exists on both sides, and in another on one side only; in the remainder it is absent.

In the true Genettes, which otherwise closely correspond to the Rasse in cranial characters, the alisphenoid canal appears to be always present.

In the Paradoxures (fig. 8) the external form of the bulla is more like that of the Civet than the Genette; but the inner or posterior chamber presents, in some species at least, the peculiarity of being

permanently distinct and moveable, not only from the other cranial bones, but also from the tympanic portion of the bulla. In form it is conical, broad and truncated behind, pointed in front, and rather compressed at the sides, which meet in a ridge. The orifice between the two cavities of the bulla is very minute, and the septum permanently double, receiving a stratum from the wall of each cavity. The carotid canal is distinct, situated near the anterior end of the inner wall of the posterior chamber of the bulla; but it appears to be never completely closed on the inner side, except by the contiguous basioccipital. The paroccipital and mastoid processes are as in the Civet. The condyloid foramen is even more concealed. The glenoid foramen is very minute. The alisphenoid canal is distinct.

In a specimen of *Nandinia binotata* in the College Museum, which otherwise agrees generally with *Paradoxurus*, the posterior chamber is entirely cartilaginous, although the cranium appears to be adult or nearly so, and the tympanic portion of the bulla is completely ossified.

Cynogale, which has a singularly modified dentition, closely resembles the *Paradoxures* in its cranial characters, even to the permanent want of union of the two portions of the bulla. The anterior chamber is very small and flat; the posterior rather more inflated and conical than in *Paradoxurus*, being more like that of *Viverra*. The carotid canal forms a deep groove, converted into a foramen by the lip of the basioccipital, placed rather in front of the middle of the posterior chamber. The paroccipital process projects beyond the bulla. There is no alisphenoid canal.

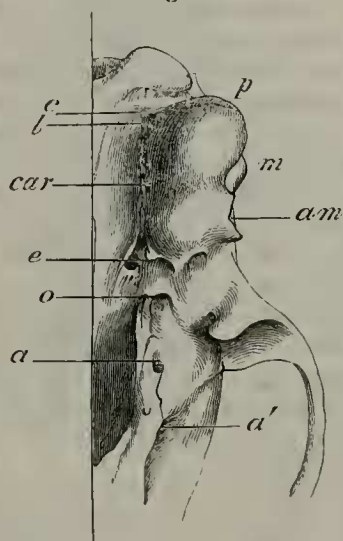
All the Herpestine members of the *Viverridae* (*Cynopoda*, Gray) present certain common characters of this region by which they can be readily recognized. The bulla (fig. 9, p. 21) is very prominent and somewhat pear-shaped, the larger, rounded end being turned backwards and somewhat outwards; a well-marked transverse constriction separates the chambers, which are now directly anterior and posterior. In front of the constriction the anterior (true tympanic) chamber is somewhat dilated again, much more than in the Civet-like *Viverrines*. The aperture of communication between the two chambers is rather larger. The carotid canal (*car*) is very distinct, situated quite at the front of the posterior chamber. The paroccipital process (*p*) does not project beyond the bulla, but is spread out and lost (in adult animals) on its posterior surface. The condyloid foramen (*c*) is concealed; the glenoid foramen is very minute or absent. The alisphenoid canal appears to be always present.

The Suricate (*Rhizocena zenik*) presents the same essential characters in a very modified form, caused by the general lateral expansion of the posterior part of the cranium. Here, and here alone among the *Viverridae*, there is a prolonged auditory meatus; but it presents the peculiarity of being fissured along the whole extent of the middle of its floor*. The anterior chamber is remarkably prominent, even more than the posterior. Externally these parts have some resemblance to those of the *Arctoidea*, but show their adherence to the *Viverrid* type in the two distinct chambers of the bulla, the ex-

* The slightly produced floor of the meatus of *Urva* is also fissured.

panded and applied paroccipital process, the concealed condyloid, and absent glenoid foramen. The carotid foramen is distinct, situated at the anterior extremity of the posterior chamber; and, as in the other *Herpestines*, the alisphenoid canal is present.

Fig. 9.



Herpestes ichneumon. From a specimen in the British Museum.

(The letters as in the preceding figures.)

The *Felidæ* and the *Viverridæ* have thus the auditory bulla and surrounding portions of the cranium formed upon a common plan distinct from that of the *Arctoidea*, the essential features of which are:—

1. The bulla is greatly dilated, rounded, smooth, thin-walled, and divided by a septum into two distinct portions, communicating only by a narrow aperture—an outer or true tympanic portion, into which the meatus externus and the eustachian tube open, and a simple vesicular inner chamber.

2. The bony meatus is extremely short; or when prolonged (as in *Rhizæna*), the inferior wall is imperfect.

3. The paroccipital process is closely applied to, and, as it were, spread over the hinder part of the bulla.

4. The mastoid process is never very salient, and often obsolete.

5. The carotid canal is small, sometimes very inconspicuous, and rarely, if ever, a true canal excavated in the substance of the wall of the bulla, but a groove converted into a canal by the basioccipital bone applied to its inner side.

6. A ridge from the paroccipital process to the condyle encloses the condyloid foramen in a common fossa with the opening of the foramen lacerum posticum.

7. The glenoid foramen is extremely minute, or absent.

The animals which possess these characters show their affinity to

each other in other parts of their organization, especially in those which were made use of in defining the Arctoidea. They all have a short simple cæcum. They all have a comparatively small penis, with a more or less conical termination, and of which the bone is small, irregular in shape, or not unfrequently altogether wanting. They all possess Cowper's glands, and a distinct lobed prostate.

The *Felidæ* and *Viverridæ* may therefore be united into another primary group, for which I would propose the name *ÆLUROIDEA*.

The two families have been chiefly distinguished by the well-known differences in their dentition; but they also show characteristic cranial distinctions. In the *Felidæ* the auditory bulla is more globular, and the inner chamber is placed really to the inner side, as well as somewhat posterior to the tympanic. The carotid canal is represented by a very minute groove placed far back on the inner side of the bulla, often quite concealed in the foramen lacerum posticum. There is no alisphenoid canal.

In the *Viverridæ* the bulla is more elongated, and the inner chamber is placed more posteriorly, usually entirely behind the tympanic. The distinction between the two parts of the bulla is better marked externally. The carotid canal is larger and placed more conspicuously and nearer the anterior part of the bulla. The alisphenoid canal is almost always present.

Cryptoprocta is a member of the *Æluroid* group, which, as long as it was known only by a single immature individual, was placed among the *Viverridæ*. The recent examination of a complete skeleton of an adult animal has led MM. A. Milne-Edwards and Grandidier to remove it completely from that group, and to ally it closely to the Cats—not indeed in the same family; for they form a tribe containing *Felis* and *Cryptoprocta* alone, each genus constituting a family by itself, the first digitigrade, the second plantigrade. The teeth are certainly more Feline than Viverrine, and so is the general appearance of the upper surface of the skull; but I cannot altogether agree in the remarks that “la conformation de la tête osseuse du *Cryptoprocta* rappelle le type félin, plus que le type viverrin,” and “en effet, s'il y avait à chaque mâchoire une prémolaire de moins, son crâne ne différerait en rien de celui des Chats” *.

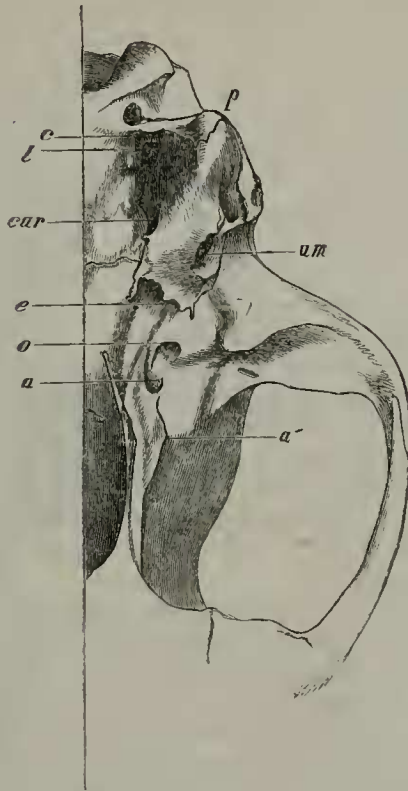
On examining the base of the cranium of the adult *Cryptoprocta* lately received at the British Museum (fig. 10, p. 23), I find that it possesses all the characters above shown to be common to the *Felidæ* and *Viverridæ*, but that it has a distinct alisphenoid canal (*a a'*), a distinct carotid foramen (*car*) near the front part of the inner side of the bulla, and the bulla itself constructed more on the viverrine than the feline type. The inner chamber is quite behind the other; it is flattened at the sides, ridged and very prominent posteriorly, and low in front. The paroccipital process does not extend beyond the bulla.

As the dentition and the general osteological characters pointed out by the authors just quoted† forbid us to place it among the *Vi-*

* Annales des Sciences Naturelles, 1867.

† The form of the scapula of the specimen at the British Museum appears to me decidedly more viverrine than feline.

Fig. 10.



Cryptoprocta ferox. From a specimen in the British Museum. The foramen between *c* and the occipital condyle is an accidental vacuity, existing only on one side of the skull. (The letters as in the preceding figures.)

verridæ as ordinarily constituted, I think, with them, that it must form a family by itself; but I look upon it as a perfectly annectent form, as nearly allied to the *Viverridæ* on the one hand as to the *Felidæ* on the other.

The visceral anatomy of *Cryptoprocta* is at present almost entirely unknown; but the little information we possess shows that in one respect it departs widely from both the families with which it otherwise appears so nearly connected—that is, in the possession of a large os penis. In the British-Museum skeleton this bone is $2\frac{3}{16}$ " long, slender, compressed, slightly curved, not grooved or divided anteriorly, rounded and slightly dilated at each end, but thickest posteriorly.

Passing over for the present the consideration of several somewhat doubtful forms, it will be convenient to examine Mr. Turner's third type of Carnivorous cranium, that of the Dog. In the genus *Canis* (figs. 11 & 12, p. 25) the auditory bulla is externally simple, smooth, and evenly rounded. The meatus has a rather prominent under lip, though less so than in the Bears. Interiorly a very incomplete septum (*s*) springs from its anterior wall in exactly the same situation as in the *Felidæ*, and divides the front part of the chamber into an

outer division, in which is the opening of the eustachian tube (*e*), and an inner one, of which the anterior end is a cul-de-sac, as in *Felis*; but this septum only extends through about one-fourth or one-third of the entire cavity, so that the two chambers communicate most freely. In the hinder part of the inner chamber are a few irregular projecting bony ridges. The bulla is developed as in the Cats, from two parts, an outer true tympanic, and an inner cartilaginous portion. At birth ossification has not commenced in the latter, and appears in the former only as the horseshoe-shaped tympanic ring.

The carotid canal (*car*) is complete, and of tolerable dimensions; but its external opening is not visible on the surface of the bulla, being deep in the foramen lacerum posticum (*l*); the course of the artery is similar to that which it takes in the Bears. The paroccipital process (*p*) is long and prominent; and its anterior surface is applied closely to the back part of the bulla, but to a less extent than in the Cats, as the process is more compressed. The mastoid (*m*) is distinct, but slightly developed. The condyloid foramen (*c*) is conspicuously situated on the ridge passing from the paroccipital to the condyle, and is quite distinct from the foramen lacerum posticum (*l*). The glenoid foramen (*g*) is very large. The alisphenoid canal (*a a'*) is present.

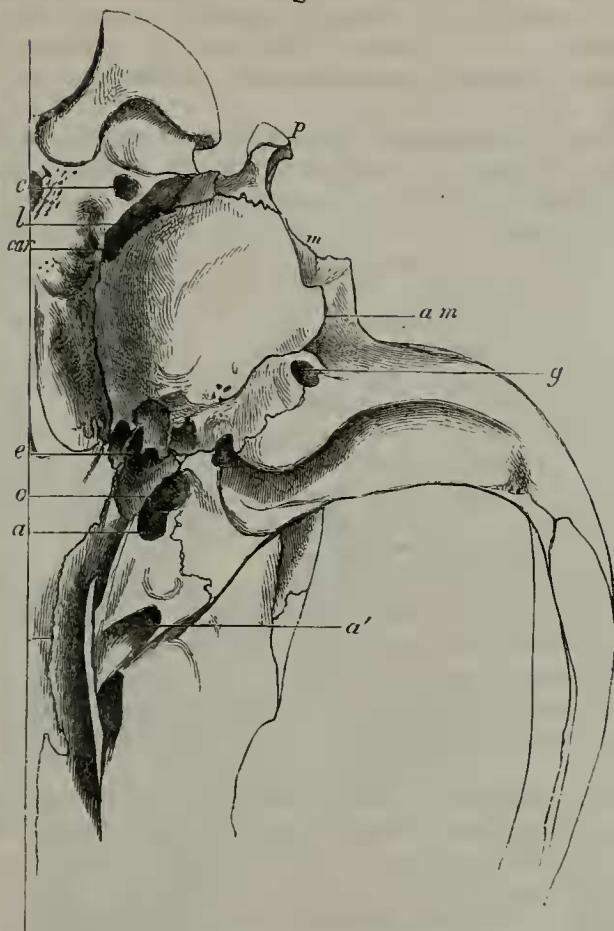
It is clear that, with these cranial characters, which are found distinctly developed (with some modifications to be noticed hereafter) in all the members of the family *Canidæ*, the Dogs cannot be placed in either of the great primary groups as above defined. They are in fact as nearly as possible intermediate between the two. The general form of the bulla and the presence of a septum, though imperfect, incline to the *Æluroid* type; while the position and development of the carotid canal, of the condyloid foramen, and of the glenoid foramen are *Arctoid* characters. The form of the paroccipital and mastoid-processes, and the length of the meatal lip, are intermediate.

Though I agree with Mr. Turner in making the Dogs a distinct primary group, which might be termed *CYNODEA*, I differ from him in placing them at one end of the series and the Bears at the other. The Dog appears to me to be the most central or generalized form of the whole order as at present existing, at least as far as the structure of the cranium is concerned. The comparative length of the folded cæcum is a special peculiarity*. The reproductive organs belong neither to the *Arctoid* nor to the *Æluroid* type, but partake of some of the characters of each. In the absence of Cowper's glands, and

* The length of the cæcum in the Dogs, among other characters, induced De Blainville to place them at the end of the series of which the Bears were at the head, the Cats, with moderate cæcum, intervening. But may not the long cæcum be rather a retention of general mammalian structure, which has been completely or partially deviated from in the Bears on the one hand, and the Cats on the other, both more specialized groups?

It should be remarked that the Dogs retain more nearly the typical number of teeth than any other Carnivores, and that some of the earliest known forms of the order appear, as far as can be gathered from their fragmentary remains, to belong to the group. Thus the Early Miocene *Amphicyon* had the teeth of a modern Dog, with an additional upper molar, completing the typical mammalian dentition.

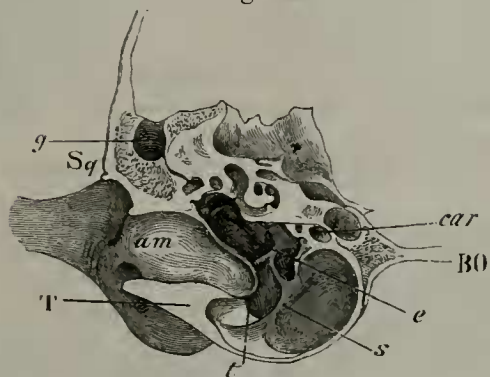
Fig. 11.



Wolf (*Canis lupus*).

(The letters as in the preceding figures.)

Fig. 12.



Section of auditory bulla of Dog.

(The letters as in the preceding figures.)

the large size of the os penis, they resemble the former, though the os is of a different form, being straight, wide, depressed, and grooved. In the distinctness of the prostate gland they approach the *Æluroids*. The bulbous dilatation of the penis during erection is a special Cynoid peculiarity.

The above-described cranial characters are very constant in all the known forms of dogs, even the most aberrant*. The principal modifications are in the size of the meatus and amount of inflation of the bulla, which appear to be in direct relation to the development of the external ear, as they reach their maximum in the Fennec. The only deviation presenting any approximation to any other family that I have observed is in *Lycaon*, in which the condyloid foramen is partly concealed by the ridge from the paroccipital as in the *Æluroids* and the *Hyæna*, an animal with which it has been supposed to have some affinity. But for this slight peculiarity, it presents no other deviation from the true Cynoid type.

Such being the three principal types of Carnivora as indicated by the modifications of the base of the cranium, I will next consider the position of certain genera about the affinities of which there has been some real or supposed difficulty.

First the *Hyænas*, which are placed by Mr. Turner without hesitation in his family *Felidæ*, equivalent, it must be remembered, to the group here called *Æluroides*, as they present, he says, "the same cranial characters as the cats." But he appears not to have noticed the peculiar septum, which forms such a marked character in the *Felinæ* or *Viverridæ*, and which is completely wanting in the *Hyænas*†.

The cranial characters of this genus (fig. 13, p. 27) are as follows:—Auditory bulla inflated, smooth, oval, most prominent posteriorly, and rather pointed in front, slightly compressed laterally. Bony meatus short, but its anterior lip slightly produced. Bulla perfectly simple within, without trace of division into compartments. Carotid foramen (*car*) distinct, near the middle of the inner side of the bulla. Paroccipital process (*p*) spread out over the posterior surface of the bulla, and forming a nodular protuberance beyond it, as in the larger *Felidæ*. Mastoid process (*m*) slightly developed. Condyloid foramen (*c*) quite concealed by the ridge from the paroccipital to the condyle. Glenoid foramen very minute or absent. No alisphenoid canal.

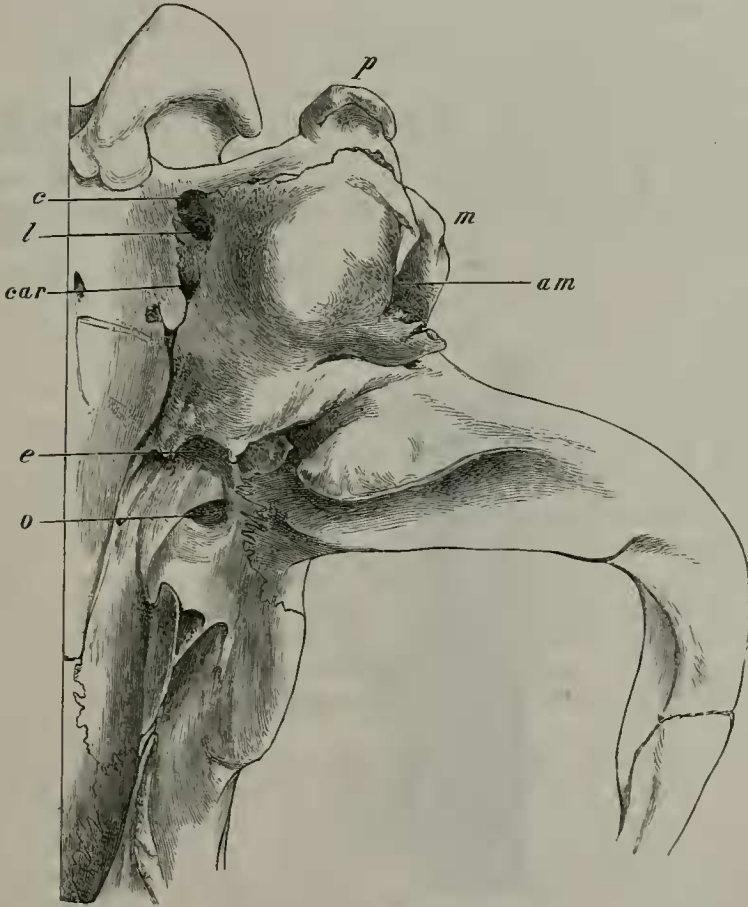
These characters all agree with the *Æluroid* type, with the exception of the absence of septum to the bulla, and when taken together are perhaps rather more feline than viverrine. The other parts of the system which have previously been made use of in the former

* I should mention that I have not had an opportunity of examining the skull of *Icticyon venaticus*; but Burmeister's figure shows its true cynoid character.

† Mr. Turner says of the *Viverridæ*, "The auditory bulla has very distinctly the appearance of being divided into two portions, of which the posterior is much the larger, and elongated in form: the more anterior division, which encloses the meatus auditorius externus, is much smaller, and partly overlapped by the other."—*Loc. cit.* p. 78. This only refers to the external appearance of the bulla, and is given as diagnostic of the bulla of the *Viverridæ* as opposed to that of the *Felidæ*.

cases lead to similar conclusions. In the presence of a short cæcum, and of Cowper's glands, and a distinct prostate, *Hyæna* conforms with the *Æluroids*. The penis is of a form unlike that characteristic of that group, being large and pendulous under the abdomen; but in the entire absence of a bone it agrees with some of the *Viverridæ*, and differs essentially from all the *Arctoid* and *Cynoid* Carnivora. The large number of rib-bearing vertebræ (fifteen or sixteen) of the *Hyænas* is a special peculiarity, as thirteen is the most usual number in the *Æluroids*.

Fig. 13.

Hyæna (*Hyæna striata*).

(The letters as in the preceding figures.)

The *Hyænas* must then form either a fourth primary division of the Carnivora, or be added, as rather aberrant members, to the *Æluroid* section. On the whole I am inclined to the latter arrangement, especially as it will be seen to gain support from the examination of the singular genus next to be spoken of.

Proteles was considered by Cuvier a "*Genette hyénoïde*." It is

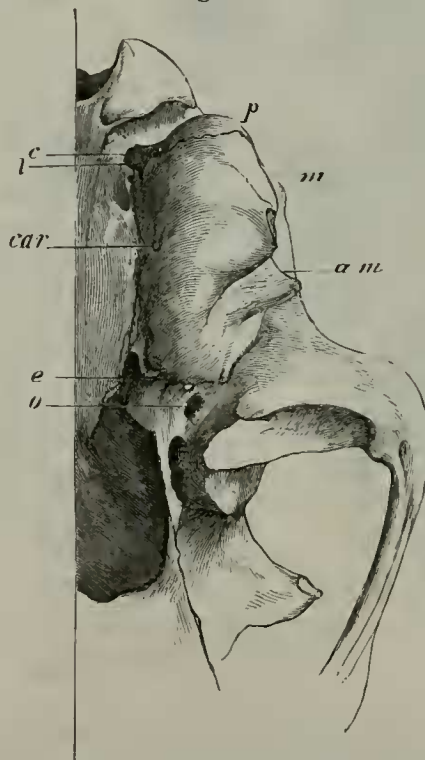
placed by Dr. Gray, in his "Revision of the *Viverridæ*" (P. Z. S. 1864), close to the genus *Viverra*. De Blainville included it in the genus *Canis*, where it is also placed, in the Catalogue of the Osteological Series in the Museum of the College of Surgeons, by Professor Owen. Many other authors have placed it in the *Hyænidæ*, as Dr. Gray in 1868 (P. Z. S. p. 525). The visceral anatomy of this animal appears at present to be quite unknown; and the rudimentary molar teeth afford no indication of its affinities. Both in external appearance and in the general characters of the skeleton it closely resembles the *Hyænas**.

The examination of the base of the cranium in this genus is therefore of great interest, as it affords in the present state of our knowledge the only true guide to its position.

Its characters (see fig. 14) are as follows:—

The auditory bulla is very large, pyriform, and everted posteriorly, almost exactly as in the larger forms of *Herpestes*. A septum divides it into two chambers, the meatal or true tympanic chamber being quite in front of the other; externally the two are completely fused.

Fig. 14.



Proteles lalandii. From a specimen in the British Museum.

(The letters as in the preceding figures.)

* The Skeleton of *Proteles* in the Leyden Museum has 15 rib-bearing vertebrae: Wagner gives 14.

The anterior lip of the meatus is considerably prolonged and thickened, as in the *Hyænas*. Its floor is not split as in *Rhynchæna* and *Urva*. The carotid foramen (*car*) is very minute, placed near the middle of the inner side of the bulla. The paroccipital (*p*) and mastoid (*m*) processes are smoothly spread over the posterior dilated end of the bulla, and form no projection beyond it. The condyloid foramen (*c*) is concealed. There is no glenoid foramen; nor is there an alisphenoid canal.

I need scarcely comment upon the value of these characters as affording a satisfactory solution to the guesses that have hitherto been made as to the affinities of *Proteles*. In the first place they are thoroughly *Æluroid*, but they do not exactly agree with either of the families of that group as hitherto defined. On the whole they approach nearest to the Herpestine section of the *Viverridæ*, but deviate from this, and approximate to the *Hyænidæ*, in two points—the development of the anterior rather than the lower portion of the lip of the meatus, and the absence of the alisphenoid canal. These, in conjunction with the general characters of the skeleton and exterior, appear to be sufficient, as in the case of *Cryptoprocta*, to warrant the formation of a distinct family, intermediate between the *Viverridæ* and the *Hyænidæ*, approaching nearest to the former. If Cuvier had called *Proteles* a Hyænoid Ichneumon, instead of a Hyænoid Genette, exception could scarcely have been taken to the description.

Another genus, whose characters were omitted in their proper place, on account of the great difference of opinion that has existed upon its true position, is *Arctictis*, the Binturong of the East Indies. Ever since its discovery this animal has oscillated between the *Viverridæ* and the *Ursidæ* without any conclusive reasons having been given for either position. F. Cuvier, Mr. Turner, and Dr. Gray assign it a place among the former group, while De Blainville, Wagner, Van der Hoeven, Giebel, Gervais, Carus, and Owen include it in the Ursine or “Subursine” group. Dr. Cantor has published some details of its anatomy, including the statement that it possesses a short cæcum; but no mention is made of the structure of the generative organs*.

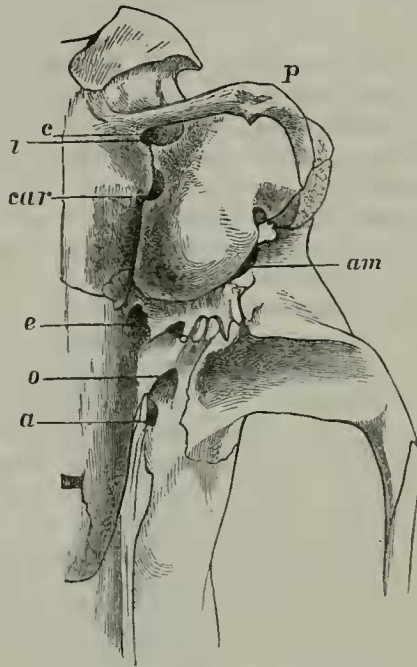
The pattern of the teeth when closely examined is clearly that of the *Paradoxures*—modified, it is true, but forming, as it were, a third term of a series of which a Civet and an ordinary *Paradoxure* are the first and second terms. Their resemblance to the teeth of *Cercoleptes*, so often insisted on by zoologists, appears to me only superficial or adaptive, and affords an instance of the difficulty of diagnosing the family characters of the Carnivora by teeth alone, which I mentioned at the commencement of this paper.

Fortunately an examination of the base of the cranium (fig. 15, p. 30) gives no uncertain indication of the animal's position. The auditory bulla and all its surrounding parts are decidedly and essentially *Viverrine*, most resembling in form those of *Paradoxurus*, though the walls of the tympanic and inner chambers of the bulla are completely fused together as in nearly all the other members of the

* Journal of the Asiatic Society, 1846, p. 192.

family. The posterior chamber of the bulla is much inflated, especially the anterior part, which overlaps the very small tympanic portion. The meatus externus (*am*) is very contracted. The carotid canal (*car*) is a deep groove near the middle of the inner wall of the bulla. The paroccipital (*p*) is closely applied to the bulla. The alisphenoid canal (*a*) is distinct. There is not the slightest approximation in any particular to the arctoid type. I feel, therefore, no hesitation in placing the Binturong among the *Viverridæ*, even without waiting for the confirmation which the examination of the structure of the organs of generation will doubtless afford.

Fig. 15.

Binturong (*Arctictis binturong*).

(The letters as in the preceding figures.)

A comparison of *Arctictis* with *Cercoleptes* supplies a good illustration of superficial and adaptive resemblance masking absence of real affinity—closer, that is to say, than ordinal affinity. They belong to two different types of the Carnivora, both modified in the same direction. One is an arboreal, prehensile-tailed, omnivorous, Viverine *Æluroid*, the other an arboreal, prehensile-tailed, omnivorous, Procyonine *Arctoid*. Geographically, each is confined to near the headquarters of the family to which it belongs; and in a functional sense only can they be regarded as representatives of each other in these different regions of the globe.

If the study of the cranial characters of the Binturong has completely removed it from all suspicion of relationship with the Bears,

and established its true position among the *Viverridæ*, the same method of observation has resulted in affording a full compensation to the former group by assigning to it the interesting little American Carnivore the *Bassaris*, frequently placed among the *Viverridæ*.

When this animal was first subjected to scientific examination, the distinctions between the different families of the Carnivora were less understood than at present; and Lichtenstein, who named it*, and Wagler, who gave a description of its external characters†, were content with pointing out that it showed resemblances on the one hand to the Raccoons and Coatis, and on the other hand to the Genettes.

The first and hitherto only published details of its anatomy were given by M. Paul Gervais, in his description of the mammals collected by MM. Eydoux and Souleyet in the voyage of the "Bonite" (1841). He gives a figure of the skeleton, and a brief description of the principal viscera, including the important statement, apparently since overlooked, of the absence of a cæcum to the intestine. He also describes the very large os penis, from which and certain other minor characters he concludes that *Bassaris* is allied to the *Mustelidæ*, although, on the whole, belonging to the *Viverridæ*, and most nearly approaching the "Mangoustes," more especially the genera *Galictis* and *Galidia*.

In his more recent 'Histoire naturelle des Mammifères' (1855), Prof. Gervais places *Bassaris* in the Tribe of "Viverrines," between which and the "Mangustins" it is said to establish a transition.

De Blainville, giving a figure of the same skeleton, places it among the *Mustelidæ*, it being evidently, he says, a "Mustela viverrin, dont en effet le système dentaire est Viverrin et le reste Mustela"‡.

Mr. Waterhouse, as early as 1839, indicated its true position in a note to his paper "On the skulls and the dentition of the Carnivora"§, saying, "From an examination of the external characters of *Bassaris astuta*, it appears to me that it belongs to this group," i. e. that division of the *Ursidæ* which includes *Procyon*, *Nasua*, &c.

Mr. Blyth in his translation of Cuvier's 'Animal Kingdom' (1840), introduces it provisionally after *Cercoleptes*, saying, in a note, "Strong presumptive evidence that the Basset (*Bassaris astuta*) does not appertain to the Viverrine group, is afforded by the restriction of the geographical range of the latter to the Eastern Hemisphere in every other instance. The presence or absence of a cæcum would decide the question."

Mr. Turner||, after quoting Mr. Blyth's observation, says, "I am not aware whether this last-mentioned point has ever been ascertained; but, from the characters presented by the cranium, I do not feel the slightest hesitation in referring this animal to the Subursine group." He, however, gives no description of these characters; and his de-

* "Erläuterungen der Nachrichten des Fran. Hernandez von den vierfüßigen Thieren Neuspaniens," Abh. Berlin Akad. 1827, p. 89. The animal was mentioned by Hernandez under the name of Tepe-Maxtlaton or Cacamitzli, meaning, according to Lichtenstein, the "Rush-Cat."

† Isis, 1831, p. 512.

§ P. Z. S. 1839, p. 137.

‡ Ostéographie, tom. ii. p. 65.

|| Loc. cit. p. 81.

cision does not appear to have affected the judgment of any subsequent author. On the contrary, of late years, *Bassaris* seems to have completely subsided into a settled position among the *Viverridæ*, as all the undermentioned systematic authors place it there, with scarcely a qualifying remark, further than that in its American habitat it forms an exception to the remainder of the group:—

Wagner, in Schreber's 'Säugethiere' (1841); Giebel, 'Die Säugethiere' (1859); Van der Hoeven, 'Handbuch der Zoologie' (1856); Baird, 'Mammals of North America' (1859); Gray, "Revision of the *Viverridæ*" (P. Z. S. 1864); Carus, 'Handbuch der Zoologie' (1868).

The external characters of *Bassaris* are too well known to require further description*. They really afford no satisfactory solution of its affinities, simply because in each of the great families of the Carnivora there is considerable variation in such characters. Either *Viverridæ*, *Mustelidæ*, or *Procyonidæ* allow of sufficient latitude in structure of feet, ears, fur, and tail, to admit of this genus being ranged among them. If coloration counts for anything, except in closely affined forms, it may be noted that it approaches *Procyon* as much as any other known Carnivore, certainly more than *Galidia*, with which Gervais compared it in this respect.

In placing *Bassaris* among the *Viverridæ* zoologists have chiefly relied upon the characters of the teeth. The dental formula is precisely identical with the prevalent one in that group, viz. I. $\frac{3}{3}$, C. $\frac{1}{1}$, P. $\frac{4}{4}$, M. $\frac{2}{2}$: total 40. The presence of a second upper molar distinguishes it from all the known *Mustelidæ*. But on the other hand the dental formula of *Procyon* and *Nasua* is exactly the same. Indeed it is extremely difficult, if not impossible, to find any substantial character which would exclude these two genera, and at the same time comprehend all the range of modifications among the *Viverridæ*, from the slender sharply cusped teeth of the Genettes and smaller Ichneumons to the massive teeth of the African Civet, the blunt rounded molars of the Paradoxures and Binturong, or the square tubercular hinder teeth of *Cynogale*. In the sole distinctive character that I have been able to find (the presence of a second cusp on the inner lobe of the upper sectorial) *Bassaris* agrees with the *Procyonidæ*.

The *Procyonidæ* as hitherto established, being a very limited group as to numbers, offer less range of dental characters; *Bassaris*, however, if included among them, will hold precisely the same relation to *Procyon* and *Nasua* as the smaller Genettes and Ichneumons do to the Civets and Paradoxures, the teeth, though formed on the same type, having a slenderer form and sharper cusps, being, in fact, merely adapted to more strictly carnivorous habits (see figs. 3 & 3a, p. 10). *Cercoleptes* deviates in its dentition from the more typical members of the group far more than *Bassaris*, though in a precisely opposite direction.

Gervais gives the number of vertebræ of his specimen as C. 7,

* A good figure from life is given in Wolf and Selater's 'Zoological Sketches,' vol. i. pl. 14.

D. 12, L. 6, S. 3, C. 22. Such a formula is perfectly exceptional, as no known Carnivore has so few dorso-lumbar vertebræ as 18. The skeleton in the Museum of the Royal College of Surgeons has C. 7, D. 13, L. 7, S. 3, C. 23 or more, the dorso-lumbar vertebræ being 20, the most usual number in the order. Although the prevailing number of the rib-bearing vertebræ of the Arctoid group is 14 or 15, and of the Æluroid and Cynoid 13, there are so many exceptions that this character cannot have much weight in determining the position of any doubtful form*.

The skull of *Bassaris* (fig. 3a, p. 10) in its general form presents a nearer approach to that of *Procyon* than to any other known Carnivore, allowing for the considerable difference of size and consequent alteration in proportion of brain-case to surrounding parts. The general form of the brain-case, and the direction and development of the zygomatic arches, are exceedingly similar. The principal differences are, that in *Bassaris* the muzzle is narrower and more pointed in front, the orbits larger and more sharply defined from the temporal fossæ by the larger postorbital processes, and especially that the bony palate is very much shorter, as it terminates at the level of the hinder border of the last molar tooth, while in the Raccoon it is continued as far as the anterior end of the pterygoid bones, or very nearly to the level of the anterior edge of the glenoid fossa. This distinction is of no more than generic importance, as similar variations in the extension of the palate backwards in the middle line are met with among different, and otherwise closely allied, members of the *Viverridæ* and of the *Mustelidæ*. The form of the lateral margins of the palate bones, of the pterygoids, and of the hinder margin of the palate itself is precisely the same in both *Procyon* and *Bassaris*.

The mandible of *Bassaris* differs from that of *Procyon* only in having the coronoid process less recurved—a very common character in the mandibles of smaller species both of the *Viverridæ* and *Mustelidæ*. In the special part of the skull which affords the most strongly marked distinctive characters between *Procyon* and the *Viverridæ*, *Bassaris* agrees in every point with the former. The auditory bulla is almost a miniature representation of that of *Procyon*; it is quite simple, without any septum, prominent at the middle part, but falling away before and behind, and prolonged externally into a well-developed bony meatus (*am*). The carotid foramen (*car*) is large, situated rather behind the middle of the inner border of the bulla. The paroccipital (*p*) and mastoid (*m*) processes, though more feebly developed than in *Procyon* (as is usually the case with smaller animals), have the same general characters, the former especially projecting outwards and backwards, quite free from the bulla. The condyloid foramen (*c*) is exposed on a flat surface, quite distinct from the foramen lacerum posticum (*l*). The glenoid

* Among the other *Procyonidæ*, *Cercoleptes* has 15, *Procyon* 14, and *Nasua* 13 pairs of ribs, though in each instance the numbers seem occasionally to vary in the same species, to judge by the discrepancy in the statements of different authors.

foramen (*g*) is large, and occupies precisely the same position as in *Procyon*; and, lastly, there is no alisphenoid canal.

There is therefore nothing questionable in the characters of this region, nothing showing even the slightest indication of an aberrant or transitional form.

Such other parts of the animal's anatomy as are known, fully confirm the cranial evidences as to its position.

Some of the viscera of the specimen which died at the Gardens of the Society in 1854, are fortunately preserved in the Museum of the Royal College of Surgeons; and among others a special preparation has been made of the junction of the ileum with the colon, confirming Gervais's observation of the total absence of cæcum. Unfortunately I have not been able to find the organs of generation, if they are preserved; but this important link of evidence is not entirely wanting. Gervais and De Blainville have described and figured the os penis of the Paris specimen, showing that it conforms to the Arctoid type. The former says, "La verge est soutenue par un os considérable, et qui a 0·050 en longueur. Il offre à sa base une espèce de tête; ensuite il est comprimé dans une partie de sa longueur et courbé légèrement, puis courbé en sens inverse, et déprimé à mesure qu'il approche de son extrémité libre, dont le bout est élargi et très-déprimé."

It will be very interesting, when opportunity offers, to complete the description of these parts, because the presence of a large os penis in *Cryptoprocta* shows that this character cannot be absolutely relied on as distinctive between the two great Æluroid and Arctoid groups. The absence of Cowper's glands, or of a prominent prostate would be more decisive.

Mr. Gulliver, in reference to the size of the blood-corpuscles, says "*Bassaris* has been alternately associated with the Bears and Viverras; as far as regards its corpuscles it agrees best with the Bears"*.

On the whole I think there can be little question that evidence enough has been adduced to prove that *Bassaris* is a member of the Arctoid subdivision of the Carnivora, and among these approaches most nearly to *Procyon* and *Nasua*.

With regard to the group of Seals, which I look upon as essentially belonging to the same ordinal division of the Mammalia as the animals hitherto treated of, the differences of the cranial characters of the three natural families into which they are divisible, *Otariidæ*, *Trichechidæ*, and *Phocidæ*, are so well described by Mr. Turner that I need only refer to his paper for them. But I must add that I cannot agree with him when he says, "I have not seen in the Seals anything which, in my opinion, warrants their approximation to any of the other families, more than another," or in his placing them and the three divisions of the terrestrial Carnivora as primary groups of equal value. The differences between the Seals and the terrestrial Carnivora both in teeth and limbs are much greater than any found between different members of the latter group. They should therefore constitute in my opinion a distinct suborder, the Æluroid, Cy-noid, and Arctoid Carnivora being united to form the other suborder.

* P. Z. S. 1862, p. 96. See also P. Z. S. 1841, p. 43.

I think moreover that there is not the slightest question that their cranial characters indicate most strongly their approximation to the Arctoid type, as has often been noticed before on other grounds*. Indeed their skulls seem to be simply a further modification of this type, showing resemblances to the true Bears on the one hand, and the Otters on the other; but I hope to take some other opportunity of examining more fully into these relationships. The presence of a cæcum in this group is a circumstance not easy to be accounted for.

Conclusion.—Mr. Turner was strongly impressed with certain resemblances, which appear to me rather superficial or accidental, between the Ichneumons and the Weasels; and it was in order to bring these groups in juxtaposition, in his synoptical table of the Carnivora, that he commenced with the Bears and ended with the Dogs, placing the *Felidæ* in the central position; in this arrangement I cannot, as I have said before, concur. The Dogs, for reasons given above, should be placed in the central position, while the *Æluroidea* occupy one flank and the Arctoids the other.

Of the former, the *Felidæ* are perhaps the most specialized, and the *Hyænidæ* the least so. The *Viverridæ* are closely connected with the *Felidæ* on the one hand, especially by the intervention of *Cryptoprocta*, and, though less closely, with the *Hyænidæ* on the other, the gap being partially closed by the annectent *Proteles*. The *Viverridæ* show a great tendency to break into two groups, of which *Viverra*, *Paradoxurus*, *Arctictis*, *Cynogale*, and *Genetta* belong to one, and *Herpestes* and its various modifications to the other, *Rhizæna* being an aberrant member of the last. The distinction between the five families of *Æluroidea* is founded mainly on the characters of the teeth, too well known to need recapitulation here; but, as shown above, the cranial characters alone would suffice to distinguish them. Africa and Southern Asia are the head quarters of the group, all the families being restricted absolutely or very nearly (two of the *Viverridæ* alone passing into Southern Europe) to these regions, except the *Felidæ*, which are almost cosmopolitan.

The Cynoidea admit of no subdivision into families; and, although there is a considerable tendency to variation in external characters, they are remarkably "true" in cranial conformation. They are perhaps the most universally diffused of any of the groups.

Of the Arctoidea the true Bears are the most specialized or aberrant; they form a very compact group, distinguished by their very characteristic dentition and their completely plantigrade mode of progression. They have a very wide geographical range. On the other hand the *Procyonidæ*, though few in numbers and restricted to the warmer and temperate parts of the American continent, are structurally less closely connected, at least if the singular *Cercoleptes* is truly a member of this group. Except for the increased number of the molar teeth, which is the only definite character by which they can be separated from the *Mustelidæ*, I see no reason for considering the *Procyonidæ* more nearly allied to the *Ursidæ* than are

* De Blainville says "Les Ours, dont les rapports avec les Phoques ont été sentis de tout temps et même par Aristote" (*op. cit.* tome ii. p. 49).

the other families of the group, or of speaking of them as specially "subursine."

Ailurus (an unfortunate name for an animal so essentially Arctoid) appears to me to be an isolated form; but until more is known of its anatomy, a very definite position cannot be assigned to it. Its dentition, though remarkably modified in character, is numerically that of the *Procyonidæ*; but certain cranial peculiarities already pointed out, and its Asiatic habitat, lead me to concur with Mr. Turner in placing it in a distinct family.

The *Mustelidæ* constitute a large, widely diffused, and somewhat disjointed group, but exceedingly difficult to reduce into natural sub-families. The most aberrant or specialized are the Otters, which, ending with *Enhydris*, run parallel to the Bears towards the Pinnipedia.

In order to exhibit at one glance the general result of this examination, I have arranged the various groups of the Carnivora in a diagrammatic plan (see p. 37), which has obviously a great advantage over a linear series in showing cross relationships, especially as it attempts to indicate, by the distances the groups are placed apart, the amount of affinity between them*.

A tree has long been a favourite image by which to illustrate genealogical descent; and we are generally accustomed to have side-views of such trees presented to us, with the stem, main boughs, and smaller branches growing from them, all in perfect order. But the ancestral records of our existing fauna are so imperfect that it would be hopeless, from our scattered fragments of knowledge of them, to attempt at present to construct such a view of the descent of any zoological group. What we may, however, do with tolerable certainty is to take a careful survey of the top of the tree (to keep up the simile) as far as it has now grown, the only part that is completely exposed to our view, and make out the mode in which the component branches are now arranged. The diagram is intended to indicate the general outline of what may be called the Carnivora tree at its present stage of growth, seen from above; or it may be said to represent a transverse section of all the diverging genetic lines, showing the amount of differentiation of the groups, and the directions they have respectively taken at this particular epoch. Similar sections, taken at different geological periods, would probably present very different appearances. Groups now sharply separated might in other times have been united by intermediate forms; and other highly specialized groups would be seen which have now entirely disappeared.

The value of this plan all depends upon whether that great zoological problem, interpretation of true affinity, has been rightly solved. It is probable that a longer and more minute study of the details of the organization of different members of the order than has yet been given will introduce many modifications in this rough sketch; it is not too presumptuous, however, to hope that ultimately it may be so perfected that every genus and even species will have its appropriate place assigned to it.

* Prof. Milne-Edwards in 1844 (*Annales des Sciences Naturelles*), and on several subsequent occasions, has made use of similar plans to illustrate his views of classification.

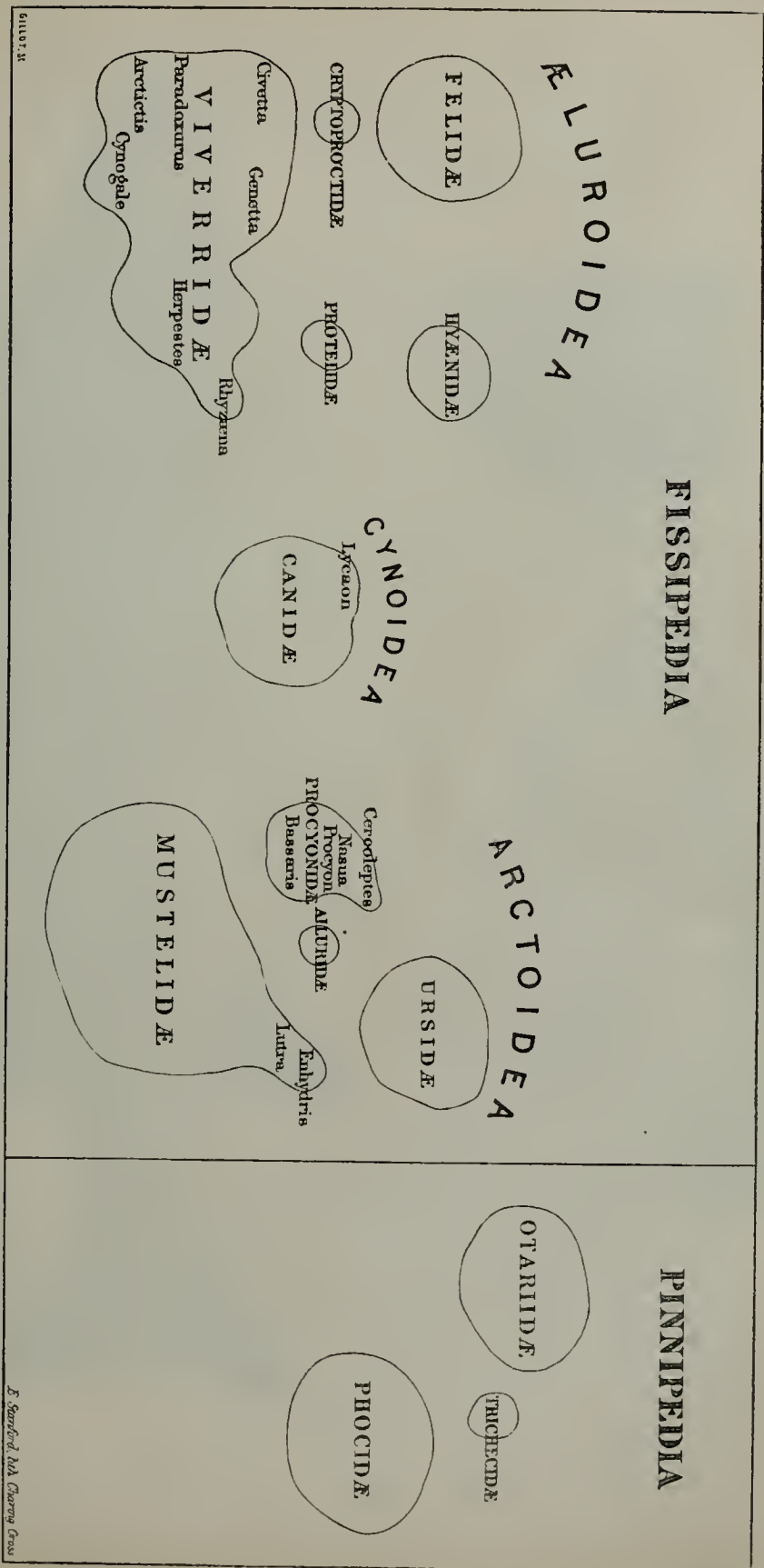


DIAGRAM OF THE RELATIONS OF EXISTING CARNIVORA.